REMARKS

Entry of the amendments to the specification, claims and abstract before examination of the application is respectfully requested. These claims patentably define over the art of record.

If there are any questions regarding this Preliminary Amendment or this application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

It is respectfully requested that, if necessary to effect a timely response, this paper be considered as a Petition for an Extension of Time sufficient to effect a timely response and shortages in other fees, be charged, or any overpayment in fees be credited, to the Account of Crowell & Moring LLP, Deposit Account No. 05-1323 (Docket #420LFK/50041).

Respectfully submitted,

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METHOD AND APPARATUS FOR LOCATING OR REDISCOVERING PARTIALLY OBSCURED OBJECTS IN IMAGES

BACKGROUND AND SUMMARY OF THE INVENTION

This application claims the priority of German patent document 199 02 681.5, filed 23 January 1999 (23.01.99) and PCT International Application No. 99/DE99/04064, filed 22 December 1999, the disclosure of which is expressly incorporated by reference herein.

This invention relates to a [process for finding] method and apparatus for locating or rediscovering partially obscured objects in images, [again] by correlation of an object reference with image values. [, as well as a system for rediscovering objects in images.]

Numerous practical uses require objects to be automatically rediscovered in images or digital image sequences. But it can happen that parts of the object are covered up or obscured by obstructions in the field of view.

In a known process for [, that facilitates the] rediscovery of objects in images, the object image to be [searched for] located stores a reference and that reference is subsequently correlated with the image within a limited range. Only part of

the reference is used during correlation and the image [dots] pixels of that reference belong to the object. Parts that do not belong to the object are masked [up] by object windowing or object masking. The [place] location of the correlation maximum supplies the current position of the object in the image, because the image [dots] pixels there agree with the object pixels.

This known process however [entails the following problem:] is problematic in that the correlation no longer provides the correct position of the object when it [the object] happens to be partly covered up, because [. Here is why:] one correlates in the covered area with image [dots] pixels that do not belong to the object. Due to this coverup, only part of the object is compared to the reference, [something that] which leads to an inaccurate recognition of the object or of the position of the object. Imprecise recognition of the coverage area very quickly yields an erroneous object position in the image.

It is therefore [the] a purpose of [this] the present invention to provide a process for rediscovering objects in images, which will facilitate precise recognition and precise determination of the object position.

Another object of the invention is to provide [Furthermore,] a system [is to be provided] for the rediscovery of objects in

images, with which the object position can be determined precisely.

These and other objects and advantages are achieved by the method and apparatus [This problem is solved by the process] for [the] rediscovery of objects according to the invention, which includes [in images according to Claim 1 and the system for rediscovering objects in images according to Claim 6. Other advantageous features, aspects, and details of the invention will emerge from the subclaims, the specification, and the drawings.

The invention-based process for the rediscovery of objects in images comprises] a correlation of an object reference with image values. If [where - if] an object is partially obscured (covered up), [-] the image values[,] that are within the coverage area in the image, [will be] are replaced by gray values of the object or of [the] an object reference, before the correlation is performed. In that way, [one can considerably reduce] the errors connected with the rediscovery of the object are significantly reduced.

As part of this process, a reference image is preferably subjected to interference windowing in order to replace the image values within an interference mask by the gray values of the

object. Advantageously, the reference image is subjected to object windowing in order to get the object reference.

In the present invention, [at hand,] especially prior to coverup, [the] an image of the complete object is stored, [in order] and is used to determine the position of the object in case of a partial coverup. Advantageously, covered parts of the object in the image are replaced by parts of a stored reference.

The invention-based system for the rediscovery of objects in images [comprises] includes a camera to take a picture, an image data memory to store an object reference, an image data processor to replace [the] gray values that lie in the image within a coverup area[,] with gray values of the object reference, and a correlation unit that correlates the image - altered by the image data processor - with the object reference. The invention-based system is able precisely to recognize the coverup area and to determine a precise object position in the image. Errors are avoided or [extensively] substantially reduced in that the already stored information on the appearance of the object is employed.

The invention is guided by a basic cybernetic idea: the system stores the image of the complete object and uses this information to [find out] determine what is behind the coverup.

[The basic cybernetic idea] This technique is patterned after [guided by] the human observer, who remembers the image of the complete object and who has an idea of what is behind the coverup. [This basic cybernetic idea is used in this invention and is expressed in technical terms, as] As a result, [of which] one can [very precisely] determine precisely the position of the object in case of partially covered objects.

Other objects, advantages and novel features of the present invention will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[The invention will be described below by way of example and with reference to the drawings.]

Figure 1 graphically illustrates the individual steps of the invention-based process; and

Figure 2 is a flow chart of the invention-based process.

DETAILED DESCRIPTION OF THE DRAWINGS

Figure 1 shows the steps of the invention-based process by way of example, on the basis of target tracking. [First of all, one can see a] The target or object 1 is initially visible, but [that,] as time goes on, it disappears behind an obstruction [a coverup] 2, which covers it up. At a certain point in time, one or [several] more parts 1a of object 1 can still be recognized, while the remaining parts of object 1 are behind [coverup] the obstruction 2. If a picture is taken at [At] that point in time, [a picture is taken and] it contains object 1 which is partially covered by [coverup] obstruction 2.

From a known reference image, [in] which [is contained] contains the target or object 1, [one now produces] an object mask 10 is produced. Object mask 10 is [supposed] superimposed with the picture that was taken and that contains target 1 behind [coverup] obstruction 2. [That] This can be done so long as part 1a of object 1 can still be seen in the image. By [superposition with] superpositioning object mask 10 with the partially obscured object and the obstruction, [one gets] an interference mask 20 is created, which is superposed on [coverup] obstruction 2. That is, interference [Interference] mask 20 consists of [contains]

those parts of [coverup] the obstruction 2 that cover the remaining parts of the object 1 in the image.

By means of an image data processor, the image [dots] pixels inside interference mask 20 are replaced by the gray values of [odds] object 1 that are taken from the reference image. This results in [One gets] a replacement 21 with image [dots] pixels that correspond to [the] just the covered parts of object 1. Replacement 21 is then inserted in the picture that was taken in the area of interference mask 20 so that the image now generated contains the complete object 1, without any parts of object 1 missing. The image, thus generated with the help of the image data processor, forms a foundation for further procedural steps.

From the stored reference image[,] (that, as described above, contains object 1), [one gets] a reference or object reference 11 is created, with the help of object mask 10. Object reference 11 is now correlated with image 22 that contains replacement 21. The correlation maximum is determined by means of a peak detection. The location [place] of the correlation maximum thus supplies the precise position of object 1 in the picture.

Figure 2 is a [flow chart showing] block diagram which shows the process [steps] for the automatic [finding] location or

rediscovery of object 1 in the picture that was taken. The data of a reference image 201 are subjected to interference windowing 202, and [. This is followed by the replacement of] those image parts 203 [-] in which the object is behind the [coverup -] obstruction are replaced with the gray [value] values of the [objects] object from the reference image in block 204. [Furthermore, the] The reference image is also subjected to object windowing 205 that, as a result, supplies the object reference. In a correlation [step,] unit 206, the object reference is correlated with the image that contains the replacement from block 204. [Last, one performs the peak detection] Finally, in order to determine the correlation maximum and the position of the object, a peak detection 207 is performed. (In the process, the reference image for example is a previously taken picture that contains object 1.)

In the method and apparatus according to the invention, [at hand,] in the search area of the image, the gray values of the [coverup] obstruction are replaced by the gray values of the object; as a result, [one gets] considerably increased precision of recognition and position determination of objects is achieved. Moreover, there [There] is considerably less intervention in the signals that are subject to correlation than during the out-masking of entire image portions. Errors during position determination are reduced considerably [reduced] by storing the

previously obtained information on the appearance of the object and by using this information to find the object behind [a coverup] an obstruction.

The foregoing disclosure has been set forth merely to illustrate the invention and is not intended to be limiting. Since modifications of the disclosed embodiments incorporating the spirit and substance of the invention may occur to persons skilled in the art, the invention should be construed to include everything within the scope of the appended claims and equivalents thereof.

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Process and System for Rediscovering Objects in Images Again

This invention relates to a process for finding objects in images again by correlation of an object reference with image values, as well as a system for rediscovering objects in images.

Numerous practical uses require objects to be automatically rediscovered in images or digital image sequences. But it can happen that parts of the object are covered up.

In a known process, that facilitates the rediscovery of objects in images, the object image to be searched for stores a reference and that reference is subsequently correlated with the image within a limited range. Only part of the reference is used during correlation and the image dots of that reference belong to the object. Parts that do not belong to the object are masked up by object windowing or object masking. The place of the correlation maximum supplies the current position of the object in the image because the image dots there agree with the object pixels.

This known process however entails the following problem: the correlation no longer provides the correct position of the

object when the object happens to be partly covered up. Here is why: one correlates in the covered area with image dots that do not belong to the object. Due to this coverup, only part of the object is compared to the reference, something that leads to an inaccurate recognition of the object or of the position of the object. Imprecise recognition of the coverage area very quickly yields an erroneous object position in the image.

It is therefore the purpose of this invention to provide a process for rediscovering objects in images, which will facilitate precise recognition and precise determination of the object position. Furthermore, a system is to be provided for the rediscovery of objects in images, with which the object position can be determined precisely.

This problem is solved by the process for the rediscovery of objects in images according to Claim 1 and the system for rediscovering objects in images according to Claim 6. Other advantageous features, aspects, and details of the invention will emerge from the subclaims, the specification, and the drawings.

The invention-based process for the rediscovery of objects in images comprises a correlation of an object

reference with image values where - if an object is partially covered up - the image values, that are within the coverage area in the image, will be replaced by gray values of the object or of the object reference, before the correlation is performed. In that way, one can considerably reduce the errors connected with the rediscovery of the object.

As part of this process, a reference image is preferably subjected to interference windowing in order to replace the image values within an interference mask by the gray values of the object.

Advantageously, the reference image is subjected to object windowing in order to get the object reference.

In the invention at hand, especially prior to coverup, the image of the complete object is stored in order to determine the position of the object in case of a partial coverup. Advantageously, covered parts of the object in the image are replaced by parts of a stored reference.

The invention-based system for the rediscovery of objects in images comprises a camera to take a picture, an image data memory to store an object reference, an image data processor to replace the gray values that lie in the image within a

coverup area, with gray values of the object reference, and a correlation unit that correlates the image - altered by the image data processor - with the object reference. The invention-based system is able precisely to recognize the coverup area and to determine a precise object position in the image. Errors are avoided or extensively reduced in that the already stored information on the appearance of the object is employed.

The invention is guided by a basic cybernetic idea: the system stores the image of the complete object and uses this information to find out what is behind the coverup. The basic cybernetic idea is guided by the human observer who remembers the image of the complete object and who has an idea of what is behind the coverup. This basic cybernetic idea is used in this invention and is expressed in technical terms, as a result of which one can very precisely determine the position of the object in case of partially covered objects.

The invention will be described below by way of example and with reference to the drawings.

Figure 1 graphically illustrates the individual steps of the invention-based process; Figure 2 is a flow chart of the invention-based process.

Figure 1 shows the steps of the invention-based process by way of example, on the basis of target tracking. First of all, one can see a target or object 1 that, as time goes on, disappears behind a coverup 2. At a certain point in time, one or several parts 1a of object 1 can still be recognized, while the remaining parts of object 1 are behind coverup 2. At that point in time, a picture is taken and it contains object 1 which is partially covered by coverup 2.

From a known reference image, in which is contained the target or object 1, one now produces an object mask 10. Object mask 10 is supposed with the picture that was taken and that contains target 1 behind coverup 2. That can be done so long as part 1a of object 1 can still be seen in the image. By superposition with object mass 10, one gets an interference mask 20 which is superposed on coverup 2. Interference mask

20 contains those parts of coverup 2 that cover the remaining parts of the object 1 in the image.

By means of an image data processor, the image dots inside interference mask 20 are replaced by the gray values of odds 1 that are taken from the reference image. One gets a replacement 21 with image dots that correspond to the just covered parts of object 1. Replacement 21 is inserted in the picture that was taken in the area of interference mask 20 so that the image now generated contains the complete object 1, without any parts of object 1 missing. The image, thus generated with the help of the image data processor, forms a foundation for further procedural steps.

From the stored reference image, that, as described above, contains object 1, one gets a reference or object reference 11 with the help of object mask 10. Object reference 11 is now correlated with image 22 that contains replacement 21. The correlation maximum is determined by means of a peak detection. The place of the correlation maximum thus supplies the precise position of object 1 in the picture.

Figure 2 is a flow chart showing the process steps for the automatic finding or rediscovery of object 1 in the

picture that was taken. The data of a reference image are subjected to interference windowing. This is followed by the replacement of those image parts - in which the object is behind the coverup - with the gray value of the objects from the reference image. Furthermore, the reference image is subjected to object windowing that, as a result, supplies the object reference. In a correlation step, the object reference is correlated with the image that contains the replacement. Last, one performs the peak detection in order to determine the correlation maximum and the position of the object. In the process, the reference image for example is a previously taken picture that contains object 1.

In the invention at hand, in the search area of the image, the gray values of the coverup are replaced by the gray values of the object; as a result, one gets considerably increased precision of recognition and position determination of objects. There is considerably less intervention in the

signals that are subject to correlation than during the out-masking of entire image portions. Errors during position determination are considerably reduced by storing the previously obtained information on the appearance of the object and by using this information to find the object behind a coverup.